

Land molluscs of forest habitats of four “Natura 2000” sites in Emilia-Romagna, with notes on the date of settlement of the alien species *Bulgarica denticulata*

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Abstract

This paper describes the land mollusc fauna of four “Natura 2000” sites in the Emilia-Romagna region, northern Italy. The study sites are located along an altitudinal transect and host different forest types. Study sites include a coastal site (Pineta di Classe), a lowland site (Ripristini di Bentivoglio), an area between the river Reno and the nearby hills (Destra Reno), and a montane site on the watershed with Toscana (Lago Brasimone). Fifty-eight species were found, approximately 11% of the Italian land mollusc fauna and 48% of the estimated fauna of Emilia-Romagna. The fauna has a strong continental affinity, with some Mediterranean elements more common in the coastal site. Among the species of conservation interest there is *Vertigo angustior* found as several empty shells at Pineta di Classe and at Destra Reno. We confirm the presence of the alien species *Bulgarica denticulata* in the pine woodlands near Ravenna (Pineta di Classe) but we hypothesize that its settlement could be a more recent event than suggested in the literature to date: no records of species referable to this taxon could be found in the 18th century literature on the molluscs of Ravenna and its nearby pine woodlands, suggesting that the arrival of this alien species in Italy could be dated between the end of the 18th century and the beginning of the 19th century.

Key Words

Land molluscs, Italy, Emilia-Romagna, *Bulgarica denticulata*, alien species.

Riassunto

[*Molluschi continentali da ambienti forestali di quattro siti “Natura 2000” in Emilia-Romagna, con note sui tempi di introduzione della specie aliena Bulgarica denticulata*]. Si descrive la fauna dei molluschi terrestri rinvenuti negli ambienti forestali di quattro siti “Natura 2000” dell’Emilia-Romagna. La collocazione dei siti lungo un transetto altitudinale che ospita diverse formazioni forestali ha permesso di massimizzare la diversità specifica rinvenuta. I siti studiati includono una pineta costiera (Pineta di Classe), un sito di pianura (Ripristini di Bentivoglio), un’area tra il fiume Reno e le colline prospicienti (Destra Reno) e un sito montano prossimo al confine con la Toscana (Lago Brasimone). Sono state rinvenute 58 specie che costituiscono circa l’11% della fauna italiana e il 48% della fauna regionale. La fauna presenta una forte affinità continentale con il 68,4% delle specie a distribuzione centro-europea. Il rimanente 31,6% delle specie è invece ristretto all’Europa meridionale. Quattro specie hanno una distribuzione totalmente o prevalentemente ristretta alla penisola italiana: *Arion* cf. *franciscus*, noto dalla Liguria orientale e dall’Appennino Settentrionale; *Retinella olivetorum*, nota per la penisola italiana e una stazione in Francia meridionale; *Vitrea etrusca*, nota per l’Italia centrale e settentrionale, nonché dalla Corsica; e *Chilostoma planospira*, nota da gran parte dell’Italia. Poche sono le specie rinvenute che hanno avuto una valutazione del loro stato di conservazione. Sulla base della recente valutazione a livello europeo, 27 delle specie rinvenute (il 42,9%) non destano preoccupazione, *C. planospira* è considerata troppo carente di dati per la valutazione, *Chondrula tridens* è invece considerata quasi minacciata, e *Vertigo angustior* vulnerabile (ed è l’unica specie compresa nell’Allegato II alla Direttiva “Habitat”, che elenca le specie che necessitano della designazione di zone speciali di conservazione). Di quest’ultima specie sono stati trovati diversi nicchi vuoti sia alla Pineta di Classe che in Destra Reno. Si conferma inoltre la presenza della specie aliena *Bulgarica denticulata* presso la Pineta di Classe. È stato ipotizzato che questa specie sia stata introdotta in Romagna ai tempi dell’Impero Bizantino, ma la letteratura malacologica del diciottesimo secolo non elenca e illustra alcuna specie riferibile a questa entità. Pertanto, riteniamo che la data di arrivo della specie sia successiva a quanto ipotizzato finora e databile tra la fine del diciottesimo e l’inizio del diciannovesimo secolo.

Parole Chiave

Molluschi continentali, Italia, Emilia-Romagna, *Bulgarica denticulata*, specie aliene.

Introduction

Invertebrates are often neglected in conservation policies notwithstanding they constitute the great majority of biodiversity (Ponder & Lunney, 1999). Major impediments to their protection include (Cardoso et al., 2011): poor public awareness, poor policymakers and stake-

holders awareness, insufficient basic knowledge such as distribution and abundance, an high number of species still to be described even in presumed well known areas like Europe (Fontaine et al., 2012) and poor knowledge on species way of life and sensitivities to habitat change. Molluscs do not make an exception to this rule. Moreover, 42% of the 693 recorded extinctions since the year

1500 are molluscs (Lydeard et al., 2004) and even more go unnoticed (Régner et al., 2009). Non-marine molluscs constitute 99% of all molluscan extinctions.

Among the objectives of the European Union Council Directive 92/43 "Habitat" there is to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the EU Member States. Species conservation is sought by identifying species "of community interest" (Annex II) or "in need of strict protection" (Annex IV) and designating special areas of conservation for the former, and enforcing prohibition of capture, killing, disturbance and trade for the latter. It is recognized that the species listed in the annexes of the Directive are poorly representative of present day conservation priorities (Bouchet et al., 1999) and often not adequately representative of European threatened biodiversity (Cardoso, 2012). However, invertebrates and continental molluscs in particular may indirectly benefit from the habitat protection enforced (which in any case is limited to a selection of habitats).

In this context, faunal studies targeting land molluscs represent a tentative to fill the knowledge gap of species distribution and abundance. The present work is based on extensive sampling in four "Natura 2000" sites in the Emilia-Romagna region, northern Italy. Sites were selected as being representative of the local major bioclimatic regions: the coast, the lowland, the riverine and hilly countryside, and the mountains. Intense sampling mainly targeted woodlands, because they are among the few natural habitats still present in the region, especially in lowland, and host the great majority of land snail species (Kerney & Cameron, 1979). However, non-quantitative sampling was carried out also outside these habitats, mainly going to and coming back from woodland sampling sites.

Previous knowledge of Emilia-Romagna land snails is exceptionally scarce and mainly dating back to the 19th century (e.g. Strobel, 1878 and the work on his collection by Bellavere & Peretti (1984); Picaglia, 1892). Among the few modern works, there are the check-list of molluscs of the province of Modena (Palazzi, 1985), a few tens of kilometres west of the study sites, and that of Zangheri (1969) listing species found in Romagna, the eastern part of the region, enclosing the coastal site included in this study. No modern works were found for the province of Bologna, where the three non-coastal sites are located. Further data can be found in very limited quantity in the material examined by taxonomic work.

Therefore, the objectives of this work are: i) to describe the molluscan fauna of these sites, contributing to the knowledge of invertebrates in the Natura 2000 network, ii) to highlight the presence of any molluscan endemic species, species of conservation interest or alien species, and iii) to provide baseline biodiversity information for future assessment of conservation efforts efficacy. The paper will also discuss the date of first settlement of the alien species *Bulgarica denticulata* (Olivier, 1801).

Materials and methods

Study area

The study was conducted in four "Natura 2000" sites of the Emilia-Romagna region along an altitudinal transect: SCI-SPA IT4070010 "Pineta di Classe" (in the province of Ravenna), SCI-SPA IT4050024 "Biotopi e ripristini ambientali di Bentivoglio, San Pietro in Casale, Malalbergo e Baricella", SCI-SPA IT4050029 "Boschi di San Luca e Destra Reno" and SCI 4050020 "Laghi di Suviana e Brasimone" (all in the province of Bologna) (Fig. 1). In the following text, it will be referred to the sites respectively as "Pineta di Classe", "Ripristini di Bentivoglio", "Destra Reno", "Lago Brasimone" for sake of brevity, and we will always refer only to the forested habitats therein.

Pineta di Classe is a coastal woodland of 0.11 km². Its surface is mostly covered by pine and oak woodland (*Pinus pinea*, *Pinus pinaster* and *Quercus ilex*). Soil is sandy and calcareous.

Ripristini di Bentivoglio is a lowland site (maximum 17 m a.s.l.), originally covered by marshes until the 18th century, then reclaimed and used for rice fields until mid-20th century. Here woodlands are mostly composed by poplar and willow (*Populus alba* and *Salix alba*), and sampling was concentrated in these areas. Soil is calcareous. Destra Reno is a diverse site on the hills south of Bologna, with two main habitats: a poplar woodland (*Salicetum albae* formation) along the right side of the Reno River, and an oak or hornbeam and maple woodland (*Knautio-Quercetum pubescentis* and *Ostryo-Aceretum opulifolii*) on the hills above. The river woodland lays between 50 and 70 m a.s.l., while the oak woodland lays between 80 and 370 m a.s.l. In the presentation of results, species preference for one or the other habitat will be highlighted. Soil is calcareous.

Lago Brasimone is a site on the Apennines, near the watershed with Toscana. It has the greatest elevation range, from 600 to 1,250 m a.s.l. The site is covered by extensive almost pure beech forests (*Fagus sylvatica*) and by other deciduous trees like oak (*Quercus cerris*, *Quercus pubescens*), hornbeam (*Ostrya carpinifolia*, *Carpinus betulus*) and chestnut (*Castanea sativa*) forests. Soils are mostly acidic.

Sampling and sorting techniques

Sampling was carried out mainly with a quantitative approach. Areas of 1 km² with homogeneous habitat cover were randomly located and will be here called sampling stations. At each station, two collecting methods were used: time-constrained visual search, and leaf litter and soil collecting and sorting. The former was carried out on three 10 × 10 m squares. Each square was searched by a single operator for 30 minutes. The latter was performed by collecting 2 litres of litter and soil down to 2 cm for five replicate. Samples were air dried and sieved down to 0.5 mm mesh. Fractions above 1 cm were searched by eye while those below under a micro-

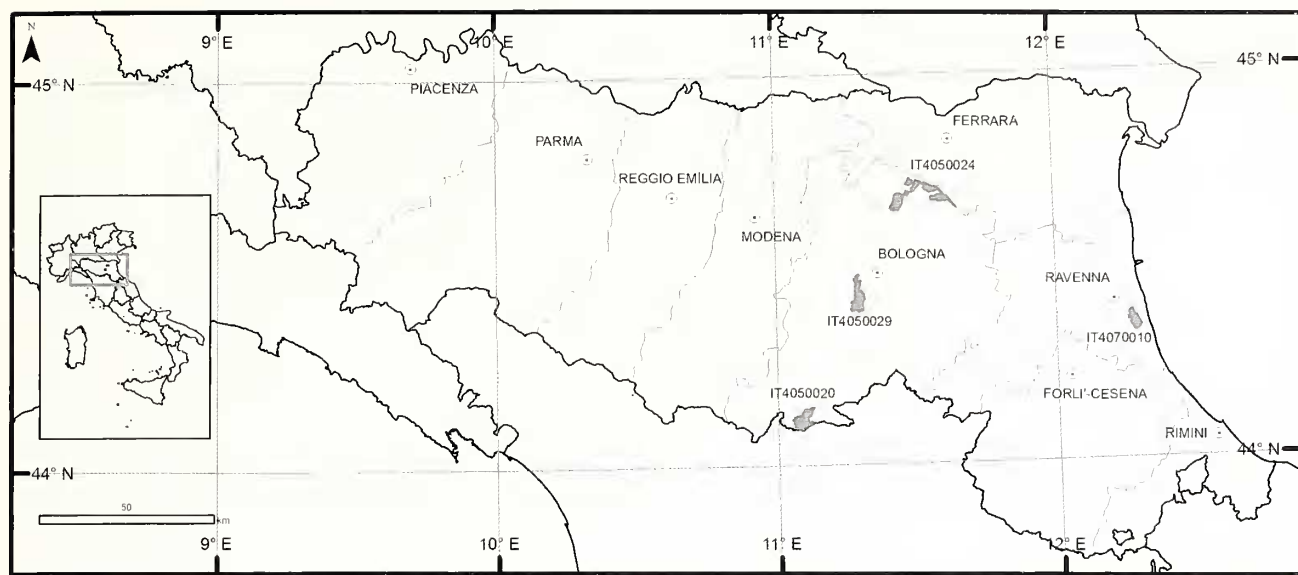


Fig. 1. Location of the study sites in the Emilia-Romagna region: SCI-SPA IT4070010 "Pineta di Classe", SCI-SPA IT4050024 "Biotopi e ripristini ambientali di Bentivoglio, San Pietro in Casale, Malalbergo e Baricella", SCI-SPA IT4050029 "Boschi di San Luca e Destra Reno" and SCI 4050020 "Laghi di Suviana e Brasimone".

Fig. 1. Posizione dei siti Natura 2000 studiati nella Regione Emilia-Romagna: SIC-ZPS IT4070010 "Pineta di Classe", SIC-ZPS IT4050024 "Biotopi e ripristini ambientali di Bentivoglio, San Pietro in Casale, Malalbergo e Baricella", SIC-ZPS IT4050029 "Boschi di San Luca e Destra Reno" e SIC 4050020 "Laghi di Suviana e Brasimone".

stereoscope. Samples were taken outside the areas of the visual search. Three visual search replicates and five soil and litter samples were collected at each station. Replicates were collected at sites distant one from each other between 10 and 50 m. Twenty stations were inspected at each site by visual search (only 5 at Ripristini di Bentivoglio due to the limited habitat extension) and 15 stations were inspected by leaf litter and soil sorting (again only 5 at Ripristini di Bentivoglio). On the way to and from quantitative sampling sites, qualitative search was carried out too.

Field activities were conducted in spring, from April to early June 2012, when favourable climatic conditions (rainfall, humidity) enhance the activity and therefore detectability of molluscs. Moreover, all visual searches were carried out during day light. This might have a reduced efficacy for slugs (Wäreborn, 1969) which are more active at night but is not expected to significantly affect the results for snails (Ward-Booth & Dussart, 2001).

Identification and taxonomy

Identification was carried out mostly to the species level, without inspection of the soft parts. Groups with little taxonomic knowledge, or for which our material did not allow definitive identifications were treated with a lumping approach and use of the "cf." or "sp." notation. Nomenclature follows the Fauna Europaea project (Fauna Europaea, 2012). The systematic arrangement follows Bodon et al. (1995) for Prosobranchia and Manganeli et al. (1995) for Pulmonata. Distributional data at the European scale mainly originates from Welter-Schultes (2012). When quoting from other Authors' papers we have kept the binomen they used. All the material here described is stored in the Museo di Zoologia dell'Università di Bologna (MZUB).

The study is based on the ca. 23,000 specimens, 8,384 of which were collected alive.

Abbreviations

sh(s): empty shells

spm(s): live collected specimens

Results

Class Gastropoda Cuvier, 1795

Family Aciculidae Gray, 1850

Platyla stussineri (O. Boettger 1884)

(Fig. 2A-C)

Material examined

Destra Reno: 1 spm.

Remarks

This single live collected specimen was found in a leaf litter and soil sample in Chiosco near Ancognano, in an area of oak woodland on the hills, at 265 m a.s.l. Bodon & Cianfanelli (2008) recorded this species in the Province of Bologna, but at a higher altitude along the Apennines watershed.

Distribution

Central and northern Italy, Slovenia.

Family Pomatiidae Newton, 1891

Pomatias elegans (O.F. Müller, 1774)

Material examined

Pineta di Classe: 3,513 spms, 2,696 shs; Ripristini di



Bentivoglio: 848 spms, 351 shs; Destra Reno: 1,661 spms, 1,009 shs; Lago Brasimone: 64 spms, 45 shs.

Remarks

This species was ubiquitous in Pineta di Classe and in Destra Reno (both on the hills and along the river). It was present in Ripristini di Bentivoglio in most sites, but not in the damper areas and marshes banks. Remarkably rare in Lago Brasimone, where it was found alive only in 15% of visual search stations and in 7% of leaf litter and soil samples. These stations are all at the south-western border of the Natura 2000 site.

Distribution

This species has a wide distribution in central and southern Europe and in northern Africa.

Family Carychiidae Jeffreys, 1830
Carychium tridentatum (Risso, 1826)
(Fig. 2D-F)

Material examined

Pineta di Classe: 18 spms, 262 shs; Ripristini di Bentivoglio: 22 spms, 290 shs; Destra Reno: 5 spms, 144 shs.

Remarks

This was an infrequent species in most sites, and absent from Lago Brasimone. It was more frequent in damper areas: live collected specimens or empty shells were found all along the Reno river, but only in 22% of the sites on the nearby hills. In Ripristini di Bentivoglio almost all specimens were found in the dampest area. In Destra Reno a specimen showing clear marks of predation was found (Fig. 2D-F). This type of damage conforms to "type 1" of Millar & Waite (2004) and it is expected to be caused by a predatory beetle. It is interesting to note that the predator peeled the shell for 1¼ whorls, an habit in common with some marine crabs (of which the most remarkable example is probably genus *Calappa*) when attacking gastropods (Vermeij, 1978). However, crabs usually start from the shell lip, while the predator of the *Carychium* did not break its lip. This may be the consequence of the much less resistant shell of the land snail and of the different morphology of the predator crushing apparatus. Crabs have a single mo-

bile finger and can grab the shell by the peristome breaking it, while beetles have mandibles which are both mobile and often sharp: they can therefore more easily break the shell wall rather than the peristome, whose thickness makes it more resistant. The identification was checked by the direct observation of the parietal fold after breaking the shell wall.

Distribution

From Europe to Caucasus and northern Africa.

Family Succineidae Beck, 1837
Succinella oblonga (Draparnaud, 1801)

Material examined

Pineta di Classe: 2 shs; Ripristini di Bentivoglio: 34 shs; Destra Reno: 4 spms, 6 shs.

Remarks

This species was found both by visual search and soil sorting, but only locally: at two sites in Pineta di Classe; at two stations in Ripristini di Bentivoglio and along the Reno river. Especially at Ripristini di Bentivoglio and Destra Reno the species was associated with the more humid habitats.

Distribution

Europe and northern Asia.

Family Cochlicopidae Pilsbry, 1900
Cochlicopa lubrica (O.F. Müller, 1774)

Material examined

Pineta di Classe: 3 shs; Ripristini di Bentivoglio: 1 spm, 38 shs; Destra Reno: 3 shs.

Remarks

This species was abundant only in the most humid areas of Ripristini di Bentivoglio, where the only live collected specimen was found in a damp area at La Riccia.

Distribution

A species with a wide European distribution.

Fig. 2. A-C. *Platyla stussineri*, height 1.6 mm. D-F. *Carychium tridentatum* with marks of predation, height 2 mm. G-J. *Truncatellina* cf. *callicratis*, height 1.6 mm, Pineta di Classe. K-N. *Truncatellina* cf. *callicratis*, height 1.7 mm, Pineta di Classe. O-R. *Truncatellina* cf. *callicratis*, height 1.9 mm, Pineta di Classe. S-V. *Truncatellina* cf. *callicratis*, height 1.9 mm, Ripristini di Bentivoglio. W-Z. *Truncatellina* cf. *callicratis*, height 2.3 mm, Destra Reno. AA-AD. *Truncatellina* cf. *callicratis*, height 2.3 mm, Destra Reno. AE-AH. *Truncatellina* cf. *callicratis*, height 1.7 mm, Destra Reno. AI-AL. *Truncatellina* cf. *callicratis*, height 1.8 mm, Destra Reno. AN-AO. *Vertigo angustior*, height 1.8 mm, Pineta di Classe. AP-AR. *Lucilla singleyana*, diameter 3.2 mm, Destra Reno.

Fig. 2. A-C. *Platyla stussineri*, altezza 1,6 mm. D-F. *Carychium tridentatum* con segni di predazione, altezza 2 mm. G-J. *Truncatellina* cf. *callicratis*, altezza 1,6 mm, Pineta di Classe. K-N. *Truncatellina* cf. *callicratis*, altezza 1,7 mm, Pineta di Classe. O-R. *Truncatellina* cf. *callicratis*, altezza 1,9 mm, Pineta di Classe. S-V. *Truncatellina* cf. *callicratis*, altezza 1,9 mm, Ripristini di Bentivoglio. W-Z. *Truncatellina* cf. *callicratis*, altezza 2,3 mm, Destra Reno. AA-AD. *Truncatellina* cf. *callicratis*, altezza 2,3 mm, Destra Reno. AE-AH. *Truncatellina* cf. *callicratis*, altezza 1,7 mm, Destra Reno. AI-AL. *Truncatellina* cf. *callicratis*, altezza 1,8 mm, Destra Reno. AN-AO. *Vertigo angustior*, altezza 1,8 mm, Pineta di Classe. AP-AR. *Lucilla singleyana*, diametro 3,2 mm, Destra Reno.

Family Vertiginidae Pilsbry, 1918
Vertigo angustior Jeffreys, 1830
(Fig. 2AN, AO)

Material examined

Pineta di Classe: 75 shs; Destra Reno: 35 shs.

Remarks

The species was found by soil sorting at only two stations in Pineta di Classe and in 67% of stations in Destra Reno, exclusively along the river. It is considered a Vulnerable species in the European Red List (Cuttelod et al., 2011) and is one of the few gastropods enlisted in Annex II of the "Habitat" Directive.

Distribution

Western Eurasia to northern Iran.

Vertigo pygmaea (Draparnaud, 1801)

Material examined

Pineta di Classe: 9 shs; Destra Reno: 2 shs.

Remarks

Localized species found only in three stations in Pineta di Classe and two in Destra Reno, by sorting leaf litter and soil. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

A species with a wide distribution in Europe.

Columella edentula (Draparnaud, 1805)

Material examined

Pineta di Classe: 2 spms, 9 shs.

Remarks

A localized species, found alive at a single site right in the center of the woodland and dead in four stations, by sorting leaf litter and soil. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

Widespread in Europe.

Truncatellina cf. *callicratis* (Scacchi, 1833)
(Fig. 2G-AL)

Material examined

Pineta di Classe: 17 spms, 401 shs. Rippistini di Bentivoglio: 31 spms, 791 shs. Destra Reno: 9 spms, 71 shs.

Remarks

Live collected specimens or empty shells of *Truncatellina* were found everywhere in Pineta di Classe and Rippistini di Bentivoglio and in 40% of Destra Reno stations. Here live collected specimens were found more often along the river rather than on the hills. The Italian fauna has four *Truncatellina* species (Manganelli et al., 1995): *T. callicratis*, *T. claustralis* (Gredler, 1856), *T. cylindrica* (Férussac, 1807) and *T. monodon* (Held, 1837). The latter is easily recognizable by the absence of ribs and has an Alpine distribution (Welter-Schultes, 2012). *T. claustralis* has the palatal tooth deeply-set and invisible from mouth, but visible externally in rear view through the transparency of the shell as a distinct white mark (Kerney & Cameron, 1979). On the contrary, the main diagnostic shell character between *T. callicratis* and *T. cylindrica* seems to be the total absence of teeth in *T. cylindrica*, despite that tooth-less specimens can be found in *T. callicratis* too (Kerney & Cameron, 1979).

Our samples from Pineta di Classe, Rippistini di Bentivoglio and Destra Reno contained almost 1,200 specimens of *Truncatellina* displaying an astonishing morphological variation. Both shell shape and sculpture and presence/absence of teeth were considered in the attempt to discriminate between *T. cylindrica* and *T. callicratis*. However, neither of the characters mentioned above allowed us to consistently discriminate between the two. Given the frequent presence of teeth, we opted for identifying all specimens as *T. callicratis*. However, the morphological variation we observed suggested to us to reconsider the presence of teeth as a key diagnostic character in this group (supporting the hypothesis of Holyoak et al., 2012) and possibly we isolated a species group rather than a single species, hence the choice to use the "cf." notation.

It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

Algeria, southern Europe to central Asia.

Family Chondrinidae Steenberg, 1925
Granaria frumentum (Draparnaud, 1801)

Material examined

Pineta di Classe: 29 spms, 82 shs; Destra Reno: 13 spms, 19 shs.

Remarks

This species was intercepted alive and dead both by visual search and leaf litter and soil sorting. At Pineta di Classe it was found in half of the stations, while in Destra Reno it was found mainly on the hills (live collected specimens only). The nominal species is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

The species *G. frumentum* (Draparnaud, 1801) is distributed from central Europe South to Italy and East to the Balkans. However, it is splitted in several subspecies. The taxon *G. frumentum illyrica* has been used for populations in Dalmatia and northern Italy so far. Recently Fehér et al. (2010) revised the distribution of these subspecies and question that *G. frumentum illyrica* is really distributed in northern Italy.

Family Lauriidae Steenberg, 1925
Lauria cyliudracea (Da Costa, 1778)

Material examined

Pineta di Classe: 1 spm.

Remarks

The single live collected specimen was found by visual search in a station with ivy at the north-western edge of the site. Remarkably, we did not find any further specimen, neither dead. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

Europe to Caucasus and Arabia.

Family Argnidae Hudec, 1965
Argna biplicata (Michaud, 1831)

Material examined

Lago Brasimone: 2 shs.

Remarks

The two shells were found south of Stagno, at the south-western border of the site, in mixed deciduous woodland. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

Alps and Apennines; isolated populations in Valencia (Spain) and north-western Greece.

Family Valloniidae Beck, 1847
Vallonia costata (O.F. Müller, 1774)

Material examined

Ripristini di Bentivoglio: 7 spms, 10 shs; Destra Reno: 2 shs.

Remarks

At Ripristini di Bentivoglio the species was extremely

localized in a damp area at La Riccia where all live collected specimens were found sorting soil. In Destra Reno it was found in only two stations along the river. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

North Africa, Europe to central Asia.

Vallonia pulchella (O.F. Müller, 1774)

Material examined

Ripristini di Bentivoglio: 11 spms, 25 shs; Destra Reno: 2 shs.

Remarks

This species was found in Ripristini di Bentivoglio in the same area where *V. costata* was found. In Destra Reno it was found at a single station along the river. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

Wide distribution in Europe.

Acanthinula aculeata (O.F. Müller, 1774)

Material examined

Destra Reno: 49 spms, 304 shs; Lago Brasimone: 17 spms, 35 shs.

Remarks

This species was found in Destra Reno both on the hills (where it was present in all the samples) and along the river (50% of stations). It was also found in 75% of stations at Lago Brasimone. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

This species has a very wide distribution covering North Africa, all of Europe to Russia and Transcaucasia, the British Isles.

Family Enidae Woodward, 1903
Chondrula trideus (O.F. Müller, 1774)

Material examined

Pineta di Classe: 28 shs; Destra Reno: 1 sh.

Remarks

This species was found in 25% of stations in Pineta di

Classe, where it was found dead only and usually worn. A single worn shell was found on the hills of Destra Reno. The lack of live collected specimens may be due to the preference of this species for more open and drier habitats (Kerney & Cameron, 1979). It is considered a Near Threatened species in the European Red List (Cuttelod et al., 2011).

Distribution

A European species.

Jaminia quadrideus (O.F. Müller, 1774)

Material examined

Destra Reno: 1 sh.

Remarks

A rare species found by visual search on the hills of Destra Reno, at the southernmost tip of the site. However, the species prefers more open and drier habitats than woodland (Kerney & Cameron, 1979). It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

A central and southern European species, ranging from Spain to Germany and northern Greece.

Merdigera obscura (O.F. Müller, 1774)

Material examined

Destra Reno: 9 shs.

Remarks

It was found in leaf litter and soil collected in more than half of the stations on the hills of Destra Reno. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

Wide distribution across Europe to Uzbekistan, north-western Africa.

Family Punctidae Morse, 1864
Punctum pygmaeum (Draparnaud, 1801)

Material examined

Pineta di Classe: 37 spms, 1401 shs; Destra Reno: 15 spms, 403 shs; Lago Brasimone: 84 spms, 274 shs.

Remarks

This species was not found in Ripristini di Bentivoglio but it was one of the most widespread and abundant species elsewhere.

Distribution

This species has a wide distribution all around Europe to West and North Asia.

Family Helicodiscidae Baker, 1927
Lucilla singleyana (Pilsbry, 1889)
(Fig. 2AP-AR)

Material examined

Destra Reno: 2 spms, 21 shs; Lago Brasimone: 3 spms, 3 shs.

Remarks

This species was found in leaf litter and soil samples in Destra Reno, mainly along the river, and in two stations at Lago Brasimone.

Distribution

This is a North American species supposed to be introduced in Europe (Welter-Schultes, 2012).

Family Discidae Thiele, 1931
Discus rotundatus (O.F. Müller, 1774)
(Fig. 3A-C)

Material examined

Pineta di Classe: 7 spms, 45 shs; Destra Reno: 5 spms; Lago Brasimone: 4 shs.

Remarks

This species was particularly abundant at Pineta di Classe, where however it was extremely localized: it was found only at two stations in the northern part of the site. Here a particularly attractive population with a

Fig. 3. A-C. *Discus rotundatus*, white colour form (broken during cleaning), diameter 4.2 mm, Pineta di Classe. **D.** *Arion* cf. *franciscoi*, length 30 mm, Lago Brasimone. **E.** *Arion* cf. *intermedius*, length 20 mm, Lago Brasimone. **F-H.** *Aegopinella pura*, diameter 2.5 mm, Lago Brasimone. **I-K.** *Oxychilus* cf. *draparnaudi*, diameter 6.7 mm, Pineta di Classe. **L-N.** *Oxychilus* cf. *draparnaudi*, diameter 8.7 mm, Destra Reno. **O-Q.** *Oxychilus* cf. *draparnaudi*, diameter 14.1 mm, Ripristini di Bentivoglio. **R-T.** *Vitrea* cf. *etrusca*, diameter 1.4 mm, Lago Brasimone. **U-W.** *Vitrea subrimata*, diameter 2.5 mm, Lago Brasimone. **X.** *Tandonia rustica*, 20 mm, Destra Reno.

Fig. 3. A-C. *Discus rotundatus*, forma di colore bianco (rottasi durante la pulizia), diametro 4,2 mm, Pineta di Classe. **D.** *Arion* cf. *franciscoi*, lunghezza 30 mm, Lago Brasimone. **E.** *Arion* cf. *intermedius*, lunghezza 20 mm, Lago Brasimone. **F-H.** *Aegopinella pura*, diametro 2,5 mm, Lago Brasimone. **I-K.** *Oxychilus* cf. *draparnaudi*, diametro 6,7 mm, Pineta di Classe. **L-N.** *Oxychilus* cf. *draparnaudi*, diametro 8,7 mm, Destra Reno. **O-Q.** *Oxychilus* cf. *draparnaudi*, diametro 14,1 mm, Ripristini di Bentivoglio. **R-T.** *Vitrea* cf. *etrusca*, diametro 1,4 mm, Lago Brasimone. **U-W.** *Vitrea subrimata*, diametro 2,5 mm, Lago Brasimone. **X.** *Tandonia rustica*, 20 mm, Destra Reno.



Land molluscs of forest habitats of four "Natura 2000" sites in Emilia-Romagna, with notes on the date of settlement of the alien species *Bulgarica denticulata*

totally white shell was found (Fig. 3A-C). In Destra Reno live collected specimens were spotted during visual search under logs.

Distribution

European species.

Family Arionidae J. Gray, 1840
Arion cf. *franciscoi* Boato, Bodon & Giusti, 1983
 (Fig. 3D)

Material examined

Lago Brasimone: 1 spm.

Remarks

The individual was found in a single station at the south-easternmost border of the site near Stagno. It was differentiated from *Arion intermedius* because of its larger size (3 cm versus 1.5 cm), darker colour, ticker skin tubercles.

Distribution

An Italian endemic, found from eastern Liguria, Toscana (only in the Alpi Apuane) and in the northern Apennines.

Arion cf. *intermedius* Normand, 1852
 (Fig. 3E)

Material examined

Lago Brasimone: 4 spms.

Remarks

The four live collected specimens were found in two stations close to each other, in the beech woodland on the right of the stream Brasimone.

Distribution

An European species.

Family Oxychilidae Hesse in Geyer, 1927
Aegopinella pura (Alder, 1830)
 (Fig. 3F-H)

Material examined

Lago Brasimone: 1 sh.

Remarks

A very rare species: a single dead but fresh specimen was found in leaf litter and soil at a single site near the spring of the Brasimone stream, in beech woodland at 1,131 m a.s.l., at the southernmost tip of the site of Lago

Brasimone, very close to the watershed and the border with Toscana.

Distribution

An European species, occurring East to Iran.

Oxychilus cf. *draparnaudi* (H. Beck, 1837)
 (Fig. 3I-Q)

Material examined

Pineta di Classe: 82 shs; Ripristini di Bentivoglio: 2 spms, 88 shs; Destra Reno: 2 spms, 4 shs.

Remarks

This species was ubiquitous in Pineta di Classe and Ripristini di Bentivoglio, while rare in Destra Reno. It was not found at Lago Brasimone. The species was intercepted mostly by leaf litter and soil sorting. However, visual search was particularly effective in Ripristini di Bentivoglio and the only collecting method who allowed the finding of the few specimens of Destra Reno. *Oxychilus* species can be unambiguously identified only when soft parts are available for the analysis of the reproductive apparatus. For this reason, we chose the "cf." notation being aware that our identification on the shell morphology might not be definitive and that we may have lumped more species in a single entity.

Distribution

Original distribution in south-western and western Europe, but nowadays worldwide dispersed.

Retinella olivetorum (Gmelin, 1791)

Material examined

Destra Reno: 60 spms, 423 shs; Lago Brasimone: 2 shs.

Remarks

This species was particularly frequent in Destra Reno, where it was found in 75% of stations on the hills, and 63% of stations along the river.

Distribution

This is a species distributed in Italy and with a relict population in southern France (Magnin et al., 2012).

Family Pristilomatidae T. Cockerell, 1891
Vitrea cf. *etrusca* (Paulucci, 1878)
 (Fig. 3R-T)

Material examined

Lago Brasimone: 4 shs.

Remarks

The specimens attributed to this species were found in a single sample of leaf litter and soil collected at the south-westernmost border of the site near Chiapporato, in mixed deciduous woodland.

Distribution

This is a species endemic to Italy and Corsica.

Vitrea subrimata (Reinhardt, 1871)
(Fig. 3U-W)

Material examined

Pineta di Classe: 11 spms, 338 shs; Destra Reno: 23 spms, 90 shs; Lago Brasimone: 69 spms, 116 shs.

Remarks

This was a frequent species in leaf litter and soil samples, found in 75% of stations at Pineta di Classe, in 47% of stations in Destra Reno (but 67% in the hills), and 93% of stations at Lago Brasimone.

Distribution

Central and southern Europe, North Africa.

Family Milacidae Ellis, 1926
Tandonia rustica (Millet, 1843)
(Fig. 3X)

Material examined

Destra Reno: 1 spm.

Remarks

A single individual was found in oak woodland at 131 m a.s.l., near Le Ganzole at the southernmost tip of the site Destra Reno.

Distribution

Central and southern Europe.

Family Limacidae Rafinesque, 1815
Limax sp.
(Fig. 4A, B)

Material examined

Destra Reno: 7 spms; Lago Brasimone: 22 spms.

Remarks

This *Limax* was found in half of the stations in Destra Reno along the river and in half of sites at Lago Brasimone. A large species exceeding 20 cm when extended.

Family Agriolimacidae H. Wagner, 1935
Deroceras cf. *reticulatum* (O.F. Müller, 1774)
(Fig. 4C)

Material examined

Pineta di Classe: 3 spms; Ripristini di Bentivoglio: 16 spms; Destra Reno: 17 spms.

Remarks

This species was found only locally at low altitude. At Ripristini di Bentivoglio it was found in two stations only near La Riccia, while in Destra Reno only in three stations along the river. It was not found in the forests of Lago Brasimone.

Distribution

Wide European distribution, now introduced world-wide.

Family Euconulidae Baker, 1928
Euconulus fulvus (O.F. Müller, 1774)

Material examined

Ripristini di Bentivoglio: 6 shs; Destra Reno: 9 spms, 21 shs.

Remarks

It was found in a damp area at La Riccia in Ripristini di Bentivoglio and in Destra Reno only along the river.

Distribution

Northern Hemisphere.

Family Ferrussaciidae Bourguignat, 1883
Cecilioides acicula (O.F. Müller, 1774)

Material examined

Ripristini di Bentivoglio: 20 shs; Destra Reno: 4 spms, 39 shs.

Remarks

This species was rather frequent in Ripristini di Bentivoglio, shells were found in 80% of sampling sites. In Destra Reno it was easier to find along the river than on the hills. It was remarkably easier to find empty shells and this may be a consequence of the subterranean living habit of the species (Kerney & Cameron, 1979).

Distribution

Europe to central Asia and northern Africa.



Fig. 4. A-B. *Limax* sp., length 110 mm, Lago Brasimone. **C.** *Deroceras* cf. *reticulatum*, length 30 mm, Pineta di Classe. **D.** *Testacella scutulum*, length 20 mm, Destra Reno. **E.** *Testacella scutulum*, length 20 mm, Lago Brasimone. **F-H.** *Testacella scutulum*, height 1.75 mm, Destra Reno. **I-K.** *Candidula* cf. *unifasciata*, diameter 6.4 mm, Destra Reno. **L-N.** *Helix lucorum*, uniform light grey colour form, diameter 36.3, Ripristini di Bentivoglio.

Fig. 4. A-B. *Limax* sp., lunghezza 110 mm, Lago Brasimone. **C.** *Deroceras* cf. *reticulatum*, lunghezza 30 mm, Pineta di Classe. **D.** *Testacella scutulum*, lunghezza 20 mm, Destra Reno. **E.** *Testacella scutulum*, lunghezza 20 mm, Lago Brasimone. **F-H.** *Testacella scutulum*, altezza 1,75 mm, Destra Reno. **I-K.** *Candidula* cf. *unifasciata*, diametro 6,4 mm, Destra Reno. **L-N.** *Helix lucorum*, individuo di colore uniforme grigio chiaro, diametro 36,3 mm, Ripristini di Bentivoglio.

Family Subulinidae P. Fischer & Crosse, 1877
Rumina decollata (Linnaeus, 1758)

Material examined

Pineta di Classe: 20 spms, 76 shs; Ripristini di Ben-
tivolio: 2 spms, 45 shs; Destra Reno: 9 shs.

Remarks

Live collected specimens in Pineta di Classe were often observed buried in the soil. It was found in the drier parts of the sites and was totally absent from the stations along the river Reno. Moreover, in Destra Reno it was found only at its northern tip, in the most disturbed parts of the oak woodlands, which is an area much frequented by people and close to buildings.

Distribution

Southern Europe and northern Africa.

Family Testacellidae Draparnaud, 1801
Testacella scutulum G.B. Sowerby I, 1820
(Fig. 4D-H)

Material examined

Destra Reno: 1 spm, 12 shs; Lago Brasimone: 2 spms.

Remarks

A rare species, possibly poorly intercepted alive because of its subterranean living habit (Kerney & Cameron, 1979). Indeed, empty shells were found much more often in Destra Reno (40% of soil samples, while it was found alive in a single station). At Lago Brasimone it was very localized: the two live collected specimens were found in a single station.

Distribution

An European species.

Family Clausiliidae Mörch, 1864
Cochlodina comensis (Pfeiffer, 1850)
(Fig. 5A-D)

Material examined

Destra Reno: 11 spms, 1 sh; Lago Brasimone: 4 spms, 4 shs.

Remarks

As for most of the clausiliids cited below, visual search proved to be much more effective than leaf litter and soil sorting for interception. In Destra Reno, only found along the river.

Distribution

Alps and northern Apennines.

Cochlodina laminata (Montagu, 1803)
(Fig. 5E-H)

Material examined

Destra Reno: 18 spms; Lago Brasimone: 17 spms, 2 shs.

Remarks

This species was found alive under dead wood in stations along the Reno river and in a few stations at Lago Brasimone. In Destra Reno, where it was found only along the river, it was observed exploiting holes in dead wood made by insect larvae as a humid refuge in exposed places.

Distribution

Europe and Caucasus.

Macrogastra attenuata (Rossmässler, 1835)
(Fig. 5Q-T)

Material examined

Destra Reno: 24 spms; Lago Brasimone: 2 spms.

Remarks

This species was found alive under dead wood.

Distribution

A central European species.

Macrogastra plicatula (Draparnaud, 1801)
(Fig. 5U-X)

Material examined

Lago Brasimone: 6 spms, 1 sh.

Remarks

A rare species found only at two stations. It was found only at Lago Brasimone. On the basis of lithology (arenaceous-pelitic rocks), this is the site with the most acidic soil. Other authors reported this species avoids low pH sites (Wäberborn, 1982).

Distribution

An European species.

Clausilia cruciata (S. Studer, 1820)
(Fig. 5M-P)



Fig. 5. A-D *Cochlodina comensis*, height 12.3 mm. E-H *Cochlodina laminata*, height 17.2 mm. I-L *Bulgarica denticulata*, height 14.5 mm, Pineta di Classe. M-P *Clausilia cruciata*, height 11.6 mm, Destra Reno. Q-T *Macrogastra attenuata*, height 15 mm. U-X *Macrogastra plicatula*, height 12.7 mm, Lago Brasimone.

Fig. 5. A-D *Cochlodina comensis*, altezza 12,3 mm. E-H *Cochlodina laminata*, altezza 17,2 mm. I-L *Bulgarica denticulata*, altezza 14,5 mm, Pineta di Classe. M-P *Clausilia cruciata*, altezza 11,6 mm, Destra Reno. Q-T *Macrogastra attenuata*, altezza 15 mm. U-X *Macrogastra plicatula*, altezza 12,7 mm, Lago Brasimone.

Material examined

Destra Reno: 5 spms, 3 shs; Lago Brasimone: 7 spms.

Remarks

This clausiliid was found both along the river and in the woodland on the hills in Destra Reno, and both in the mixed deciduous forest and in the beech forest at Lago Brasimone.

Distribution

An European species.

Bulgarica denticulata (Olivier, 1801)
(Fig. 5I-L)

Material examined

Pineta di Classe: 473 spms, 503 shs.

Remarks

This species was found alive almost everywhere in the site of Pineta di Classe. It was intercepted alive both with visual search (90% of stations) and leaf litter and soil sorting (60% of stations). If also empty shells are considered, the species was ubiquitarian. The species was easily observable during our day light sampling in exposed places, like on bark and trunks, and also among dead leaves.

Distribution

In Italy it is an alien species, whose original distribution is south-eastern Europe and western Turkey (see Discussion).

Family Hygromiidae Tryon, 1866
Xerotricha conspurcata (Draparnaud, 1801)

Material examined

Ripristini di Bentivoglio: 41 spms, 44 shs; Destra Reno: 2 shs.

Remarks

This species was found alive at a single station at Ripristini di Bentivoglio, where it was found by visual search under fallen tree branches. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

A southern European species.

Candidula cf. *unifasciata* (Poiret, 1801)
(Fig. 4I-K)

Material examined

Destra Reno: 1 spm, 62 shs.

Remarks

This species was found mainly on the hills of Destra Reno, sorting leaf litter and soil. Notwithstanding the several empty shells found, only a single live collected specimen was collected. This may be due to the species preference for dry open places (Kerney & Cameron, 1979) rather than the forested habitats targeted by our research. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

A central European species.

Hygromia cinctella (Draparnaud, 1801)

Material examined

Pineta di Classe: 18 spms, 121 shs; Ripristini di Bentivoglio: 2 spms, 101 shs; Destra Reno: 8 spms, 39 shs; Lago Brasimone: 2 shs.

Remarks

This was a common species throughout our survey with the only exception of Lago Brasimone where only 2 very worn specimens were found. It was found often alive on or under the leaves of plants. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

Central and southern Europe.

Cernuella cisalpiua (Rossmässler, 1837)

Material examined

Pineta di Classe: 243 shs; Ripristini di Bentivoglio: 138 shs; Destra Reno: 9 shs.

Remarks

Remarkably, we were not able to intercept live collected specimens in our quantitative samples, notwithstanding the high number of empty shells found. As for *Candidula* cf. *unifasciata*, the species may prefer more open habitats than woodland. It is also tolerant to ruderal habitats and a few living specimens were found within the woodland near buildings. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

A southern European species.

Cermuella neglecta (Draparnaud, 1805)

Material examined

Pineta di Classe: 1 spm, 87 shs; Ripristini di Bentivoglio: 13 shs.

Remarks

As for other hygromiids, we found several empty shells but a single live collected specimen, possibly because of their preference for drier and more open habitat than woodland (Kerney & Cameron, 1979). It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

An European species.

Ciliella ciliata (W. Hartmann, 1821)

Material examined

Lago Brasimone: 1 sh.

Remarks

A single specimen was found on the western border of the site, in mixed deciduous woodland with oak, hornbeam and chestnut. Giusti et al. (1985) reported it as a very rare species in Italian forests. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

From the eastern Pyrenees to Alps and the Apennines.

Trochoidea trochoides (Poiret, 1789)

Material examined

Pineta di Classe: 25 shs.

Remarks

This species was found in almost half of the stations, but always dead and worn. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

A coastal western Mediterranean species.

Monacha cantiana (Montagu, 1803)

Material examined

Pineta di Classe: 1 spm, 75 shs; Ripristini di Bentivoglio: 2 spms, 472 shs; Destra Reno: 83 spms, 55 shs.

Remarks

This species was particularly common in Destra Reno, where several live collected specimens were found in woodland. The species was widespread as most stations along the river (88%) and on hills (42%) had it. It was usually found on vegetation. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

Originally Italy and southern France, but introduced to central Europe and the British Isles.

Monacha cartusiana (O.F. Müller, 1774)

Material examined

Pineta di Classe: 3 shs; Ripristini di Bentivoglio: 4 shs; Destra Reno: 2 shs.

Remarks

This was apparently a rare species in our survey. However, while we are reasonably confident about the identification of adult *Monacha*, the identification of the many juvenile and often worn empty shells found in the leaf litter and soil samples proved very difficult. We can't exclude that the frequency and abundance of this species was underestimated due to misidentification of such specimens with *M. cantiana*. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

Wide European distribution from Portugal to Ukraine.

Family Cochlicellidae Schileyko, 1972
Cochlicella acuta (O.F. Müller, 1774)

Material examined

Pineta di Classe: 12 shs.

Remarks

This is a typical maritime species and indeed it was found in Pineta di Classe only. The absence of live collected specimens from our quantitative samples in woodland may be due to the preference of the species for more open and drier habitats (Kerney & Cameron, 1979). Live collected specimens were collected outside the stations after rain near the visitors centre of the reserve. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

Coasts of the British Isles, western Europe, Mediterra-

nean coasts of Europe and then eastward to the Middle East.

Family Helicodontidae Kobelt, 1904
Helicodonta obvolvata (O.F. Müller, 1774)

Material examined

Destra Reno: 23 spms, 68 shs; Lago Brasimone: 7 spms, 18 shs.

Remarks

This species was rather frequent in Destra Reno where it was found in 55% of stations (along the river and on the hills alike). It was also present in 50% of stations at Lago Brasimone. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

An European species.

Family Helicidae Rafinesque, 1815
Chilostoma planospira (Lamarck, 1822)

Material examined

Lago Brasimone: 4 shs.

Remarks

The few empty shells were found in stations spread over the site. A living specimen was observed outside stations near Bagno. It is considered a Data Deficient species in the European Red List (Cuttelod et al., 2011).

Distribution

This is a species endemic to Italy.

Eobania vermiculata (O.F. Müller, 1774)

Material examined

Destra Reno: 2 shs.

Remarks

This species was found at a single station on the hills of Destra Reno: Monte Belvedere. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

A species originally found in southern Europe, but now introduced to many other countries.

Cepaea nemoralis (Linnaeus, 1758)

Material examined

Pineta di Classe: 1 spm, 88 shs; Ripristini di Bentivoglio: 12 spms, 265 shs; Destra Reno: 2 spms, 7 shs; Lago Brasimone: 1 sh.

Remarks

At Ripristini di Bentivoglio, this species was found alive or dead in all samples. However, live collected specimens were rare, notwithstanding the abundance of empty shells. It was also rather frequent at Pineta di Classe, where it was present in 60% of sampling sites. In Destra Reno it was found only along the river where the few specimens found were spread over most stations (63%). The only specimen found at Lago Brasimone had an attractive salmon pink pattern. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

An European species.

Cornu aspersum (O.F. Müller, 1774)

Material examined

Pineta di Classe: 3 spms, 22 shs; Ripristini di Bentivoglio: 7 shs.

Remarks

The species was found in 55% and 40% respectively of the stations of Pineta di Classe and Ripristini di Bentivoglio, despite that live collected specimens were rarely encountered. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

Originally a species spread around the Mediterranean Sea, but now introduced worldwide.

Helix cincta O.F. Müller, 1774

Material examined

Pineta di Classe: 5 spms, 20 shs; Destra Reno: 22 shs.

Remarks

At Pineta di Classe the species was extremely localized: specimens were found only at two stations in its northernmost part. In Destra Reno the species was found only on the hills, but quite widespread along the site. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

A southern European species ranging from northern Italy to Turkey and Lebanon.

Material examined

Pineta di Classe: 12 shs; Ripristini di Bentivoglio: 627 spms, 1099 shs; Destra Reno: 1 spm, 120 shs.

Remarks

This species was incredibly abundant in Ripristini di Bentivoglio, where at some sites it was necessary to be extremely careful when walking to avoid stepping on specimens. At this site an unusual colour variation was found (Fig. 4G-I): the shell was uniformly light grey, but no differences could be noticed in the colour pattern of the animal. It is considered a Least Concern species in the European Red List (Cuttelod et al., 2011).

Distribution

A species found from southern Europe to the Middle East.

Discussion

Comparison with the Italian fauna and other local faunas

The 58 species here found are approximately 11% of the Italian land mollusc fauna (Manganelli et al., 2000) and 48% of the fauna of Emilia-Romagna (preliminary unpublished checklist by the Authors). Of the 57 species which were identified at the species level, 46 (80.7%) are characterized by a wide distribution in Europe, while 7 (12.3%) have a distribution restricted to one to few countries. Among these, four species have a distribution mostly restricted to Italy or are Italian endemics: *Arion* cf. *franciscocoloi*, endemic to area from eastern Liguria to the northern Apennines, *Retinella olivetorum*, distributed all along the Italian peninsula and in a relict area in southern France; *Vitrea etrusca*, with a distribution restricted to northern and Central Italy and Corsica; *Chilostoma planospira*, distributed along most of Italy. Most of the species found (39, 68.4%) have a distribution which covers central Europe, while the remaining 18 (31.6%) are restricted to southern Europe.

These figures are typical of the fauna of Emilia-Romagna. Palazzi (1985) described the fauna of the province of Modena cumulating data from personal collecting and the literature. This province neighbours the province of Bologna on its western side and shares with it a similar altitudinal excursion ranging from ≈ 2000 m a.s.l. to lowland near the river Po. After a few taxonomical emendations, his work listed 72 species, sharing almost 60% of the species with our findings and maintaining the same strong continental affinity. This figure may rise up to 68% if the identification of a few species could be better reconciled with the modern nomenclature we fol-

lowed. Among the species cited by Palazzi we did not find, there are some species with a southern France-north-western Italy distribution which might find in the Province of Modena their easternmost distribution in Emilia-Romagna like *Granaria variabilis* (Draparnaud, 1801), *Solatopupa similis* (Bruguere, 1792) and *Itala itala* (von Martens, 1824) and some other rare species, like *Renea elegantissima* (Pini, 1886) and *Vertigo moulinsiana* (Dupuy, 1849). Most other species have a wide distribution in Italy and Europe and could possibly also be part of the fauna of the provinces we investigated rising even more the degree of similarity between the two territories.

Zangheri (1969) described the fauna of Romagna, neighbouring the province of Bologna on the East and including the site "Pineta di Classe". After clearing evident misidentifications and updating the nomenclature, again a significant overlap with our study could be noticed: 58.5% of the species are in common between the two lists, and up to 64.6% if the identification of a few species could be again better reconciled with the modern nomenclature we followed. Among the other species Zangheri cited, some are southern species which find their northern range limit in Romagna, like *Semilimacella bonelli* (Targioni Tozzetti, 1873), *Tandonia sowerbyi* (Férussac, 1823), *Ferussacia folliculus* (Schröter, 1784), *Siciliaria gibbula* (Rossmässler, 1836), *Papillifera bidens* (Linnaeus, 1758), *Monacha martensiana* (Tiberi, 1869) and *Theba pisana* (O.F. Müller, 1774). Some of them do not live in coastal pine woodlands, and hence their absence in our survey. Most other species we did not find have a wider European or Mediterranean distribution and could well be found in the territories we surveyed if a wider range of habitat would have been investigated, again rising even more the degree of similarity between our study sites and Romagna.

Conservation interest

The conservation status of 30 of the 63 species found (47.6%) was evaluated in the European Red-List of non-marine molluscs (Cuttelod et al., 2011). A single species, *Chilostoma planospira*, was considered Data Deficient (DD). Most species (27, 42.9% of the whole fauna) were listed as Least Concern, while *Chondrula tridens* was the only species being listed as Near Threatened (NT). A single threatened species was found: *Vertigo angustior*, which was listed as Vulnerable (VU). *Vertigo angustior* is also listed among the species in need of designation of special areas of conservation (Annex II) in the "Habitat" Directive. However, in Italy the species seems to have a better conservation status (Manganelli et al., 2000).

Arrival of the alien species *Bulgarica denticulata*

The history of the presence of *Bulgarica denticulata* in Romagna is complicated by an articulated nomenclatural history. The species was listed as *Bulgarica thessalonica* (Rossmässler, 1839) in the Checklist of Italian Fau-

na (Manganelli et al., 1995). Zangheri (1969) listed the species as *Laciniaria plicata* (Draparnaud, 1801) and a nice illustration of specimens from Romagna was provided by Lazzari (2007) under this name.

Zangheri's record suggests that the species is present in the area at least since the mid 20th century. However, Tassinari (1854) recorded *Clausilia semidenticulata* Pfeiffer, a taxon now considered a synonym of *Bulgarica denticulata*, from the Ravenna pine woodlands. He already described it as an alien: he recorded the species from the pine woodlands of Ravenna and specified that "*Sinora non era stata rinvenuta che nell'Asia minore, donde forse venne trasportata a Ravenna colle navi durante la sua dipendenza dall'Impero d'Oriente*" [to date, the species has been found only in Turkey. Probably it was brought to Ravenna by ships during the Byzantine Empire]. The same hypothesis was proposed in recent times in a review of the modes of introduction of continental molluscs to Italy (Hallgass & Vannozzi, 2010). Despite that this is a plausible explanation of the introduction of the species to Italy, it is interesting to note that in the 18th century Ginanni (1757) did not record anything similar. The work by Ginanni is prelinnean, so it is not straightforward to recognize modern taxa in there. However, *Bulgarica denticulata* is a sinistral species, an easy character to trace even in ancient works with poorly detailed illustrations of small sized species like Ginanni's one. The only sinistral species illustrated in the plates is on plate III of the land snail section, figure 23 (Fig. 6). The figure does show sinistrality, but obliterates any further diagnostic character. The figure corresponds to "*turbine terrestre minore*" as described on page 59. The diagnosis is however quite clear in describing something different than *Bulgarica denticulata*: "*di color terreo, che ha nove giri nella voluta, e nell'unione di ciascuno di essi è sparso di piccole tuberosità bianchiccie, che fanno dentati i giri medesimi. Il primo di questi, che forma la bocca, e si dilata un poco a foggia di tromba, è contornato da un labbretto bianco, e tutti sono rigati orizzontalmente. L'ho ritrovato negli Orti di Ravenna, che sono circondati di muri.*" [brown, with 9 whorls, sutures with small white tubercles; due to these tubercles, the appearance of the whorls is denticulate. The aperture is slightly inflated and with a white border. All

the whorls are longitudinally striated. Found in gardens surrounded by walls in Ravenna]. The reference to the white subsutural protuberances suggests this to be *Papillifera bidens* (Linnaeus, 1758) rather than *Bulgarica denticulata*. More than 30 years later, a major work by Ginanni on the social and natural history of the pine woodlands of Ravenna was published posthumously (Ginanni, 1774). In the section on molluscs there is often reference to the work of 1757. However, there is no record of the "*turbine terrestre minore*" nor of any other species which might resemble a clausiliid. Today, *Bulgarica denticulata* is a highly frequent and abundant species in the pine woodlands of Ravenna. If the colonization has to be dated back to the Byzantine Empire, it can be hypothesized that the species in the 18th century had already had enough time to spread and form consistent populations similar to the ones we see today. In this perspective, the lack of any reference to a similar species in Ginanni's works is compelling. Despite that the evidences collected in the ancient literature cannot be considered conclusive on the date of colonization of Ravenna's pine woodlands by the species, we suggest that its colonization might have been more recent than considered to date, and datable between the end of the 18th century and the beginning of the 19th century.

Conclusions

This is one of the few faunistic works dealing with the land snail fauna of Emilia-Romagna region. The choice of sites along an altitudinal transect and with different forested habitats contributed to increase the diversity we managed to intercept. Fifty-eight species are here recorded, they represent approximately 11% of the Italian land snail fauna and 48% of the estimated fauna of Emilia-Romagna. Our study evidenced the presence of a vulnerable species, *Vertigo angustior*, and of a near threatened one, *Chondrula tridens*. Moreover, the alien species *Bulgarica denticulata* was found widely distributed in the coastal site of Pineta di Classe, near Ravenna. On the basis of the ancient literature, we hypothesize that the settlement of this species in the area is more recent than previously considered, and may be dated between the end of the 18th century and the beginning of the 19th century.

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Fig. 6. "*Turbine terrestre minore*", the only sinistral shell referable to a clausiliid reported by Ginanni (1757). It is probably *Papillifera bidens*, as its description suggests.

Fig. 6. "*Turbine terrestre minore*", l'unica conchiglia sinistrorsa riferibile ad un clausiliide riportata da Ginanni (1757). Si tratta probabilmente di *Papillifera bidens*, come suggerito dalla descrizione.

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